

ART. X. THE CHAZY CONULARIDA AND  
THEIR CONGENERS

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(PLATES I-III)

INTRODUCTION

The Chazy limestone in the St. Lawrence and Champlain Valleys has been studied by Billings, Raymond, Hudson, Ruedemann, Twenhofel, and others, and its large and diverse fauna is well known. Among the many species described from the Upper Chazy (Valcour formation) are two species of *Conularia*, *C. triangulata* Raymond, 1905, and *C. par-roquetensis* Twenhofel, 1938. Four new species from equivalent beds near Montreal, Quebec, can now be added to these.

The six species exhibit in themselves such differences of structure that it has been thought necessary to assign them to three genera. *C. par-roquetensis* has already been discussed and referred to *Metaconularia* (Sinclair, Trans. Royal Soc. Canada, 1940, sec. iv, p. 104). The other five species, for which two new generic names are proposed, together with some allied species form the subject of this paper.

These conularids are of particular interest because they are the earliest definite representatives of the group to appear in America. Two older forms have been described, but *C. cambria* Walcott, 1890, has been shown to be a trilobite fragment (Raasch, Geol. Soc. Am., Spec. Paper 19, p. 104, fn.), and *C. pristina* Clark, 1924 (Bull. Amer. Pal., 41, p. 84), is a very doubtful fossil. Undoubtedly other species will be found in the earlier Ordovician, but so far these Chazyan forms are the oldest known from this continent.

I have been able to study some of the specimens described here through the kindness of the following curators and individuals: Miss M. A. Fritz, Royal Ontario Museum of Palaeontology; Percy E. Raymond, Museum of Comparative Zoölogy; Charles E. Decker, University of Oklahoma; Carl O. Dunbar, Peabody Museum of Natural History; T. H. Clark, Peter Redpath Museum; Harry S. Ladd, U. S. National Museum; I. P. Tolmachoff and E. R. Eller, Carnegie Museum; and James A. Calder,

Jr., of Ottawa, Canada. To these I owe my thanks, as well as to Archie Lamont, Birmingham; E. D. Currie, Glasgow; and Per Thorslund of Stockholm, for information concerning foreign species.

### **Conularina**, new genus

Conularida in which each face bears a low mesial ridge flanked by shallow depressions which appear on the inner side of the shell as low ridges, and in which the surface is ornamented by fine irregular striae.

*Genotype*: *Conularina triangulata* (Raymond).

Most of the species referred to the genus also agree in having the striae crossed by finer oblique folds near the shoulders of the angles. These may be true growth-lines, indicating the course of the apertural edge of the shell. If such is the case, this margin was produced in high triangular lobes. There is no direct evidence of the nature of the aperture. All the known specimens are broken apically, and the nature of the apex is unknown. No apical diaphragm has been seen.

The two longitudinal depressions forming internal ridges suggest possible relationship with *Metaconularia*. In the latter genus, however, the surface shell layers are not involved in the making of the "septa"; there is no evidence of an internal rod in *Conularina*. In several specimens there is a distinct tendency for one of the mesial depressions to be stronger than its mate. If this tendency were pursued until the shallower depression disappeared, a shell much like *Conularia kjerulfi* Holm (1884, p. 130)<sup>1</sup> would result.

The four Chazy species and that from the Black River, all described below, are the only known forms. None of the described European species seem to be congeneric.

### **Conularina triangulata** (Raymond)

(Plate I, figures 4-10)

1905. *Conularia triangulata* Raymond, Amer. Jour. Sci. xx, p. 379.

1908. *Conularia triangulata* Raymond, Ann. Carnegie Mus., iv, p. 216, pl. liv, fig. 18.

Raymond's description is quite sufficient to identify the species, but as some additional notes are desirable a new description incorporating them is offered:

<sup>1</sup> See bibliography appended.

Shell of medium size, slightly curved, tapering more rapidly towards the apex. Test very thin, becoming thicker at the angles; in places of at least four layers; usually black in colour. Faces slightly concave, equal, apical angle  $13-15^{\circ}$  near the apex, becoming about  $9.5^{\circ}$  towards the aperture. Cross-section, an equilateral triangle with the angles slightly truncated. Marginal grooves rather wide (0.8-1.5 mm.), flat and shallow, with sharp borders, the bottom sometimes marked by a low mesial ridge; near the apex the internal cast shows a sharp mesial depression. Mid-line of the face marked by a low ridge about 0.3 mm. wide, flanked by shallow depressions; both the ridge and the depressions more prominent on the cast. The surface marked by numerous fine lirae (16-20 in a length of one mm.) which cross the face in a shallow double-sigmoid curve, being almost horizontal at the mid-line, and rising to the shoulder of the angle where they turn slightly apicad. These lirae are low and frequently obscure near the middle of the face, but become sharp and bifurcate once or twice towards the shoulder; they are smooth except on the shoulder of the angle, where they are serrated by still finer threads which cross them obliquely. The internal cast usually bears the impression of the transverse striae, much less clear than on the surface. Apart from the oblique threads there is no longitudinal ornamentation. Apex and aperture unknown.

Length of the type, 39 mm.; of the plesiotype, plate I, figures 4-7, 23 mm. Width of face, 7 and 8.5 mm., in the two specimens, respectively.

*Types:* The holotype, a well-preserved specimen partially imbedded in the matrix, bears number 2,099, in the Carnegie Museum. Plesiotypes are in the collections of James A. Calder Jr., of Ottawa, and of the author.

*Occurrence:* Raymond's type came from the Valcour at Cystid Point, Valcour Island, and he also mentioned its occurrence at Smugglers' Bay. Fragments are somewhat common in a bryzoan-brachiopod coquina at Village Belanger, just north of Montreal. At this locality most of the specimens owe their preservation to encrustation by bryzoans. Mr. Calder's specimen was found about eight miles north-east of this locality, and about two miles south of Terrebonne. The beds at these Quebec localities are believed to be equivalent in age to the Valcour.

*Remarks:* The most striking feature of this species is, of course, its shape. Three-sided specimens of conularids are not unknown, but in other cases it is demonstrable that the specimen is an abnormal individual of a species ordinarily possessing the usual four faces. Over a dozen specimens of *C. triangulata* have been seen, all showing the same cross-

section, and it is apparent that this was the normal form of the species. The ornamentation is constant and distinctive. Even isolated fragments of the shell, showing no cross-section, are unmistakable.

Raymond described the species as having six sides, and it has been referred to in this way by other writers. There seems to be no reason for regarding the short "sides" as such: they are no wider proportionately than are the marginal grooves in many other species. That they are flat instead of concave is not significant. The lengthwise curvature of the shell is not seen in all specimens, but it is presumed that this is due to the fragmentary nature of many of them. All specimens of any length show at least a trace of bending. It is very possible that the shell became comparatively straight with age, but too few good specimens are known to be certain.

***Conularina undosa*, sp. nov.**

(Plate II, figures 1, 2)

*Description:* Shell of moderate size, straight, tapering regularly. Test thin, of two layers except when thickened near the angles, black or blue-black in colour. Faces equal, flat or a little concave, apical angle  $9^{\circ}$ . Cross-section square. Marginal grooves wide and deep; the edges broadly rounded, to such an extent that the angles of the shell are materially truncated; the bottom of the groove apparently smooth, underlain by about five layers of shell material. Mid-line of the face with a very low, flat ridge, 0.3 mm. wide, flanked by shallow linear depressions. No internal structure seen. Surface with low, rather broad, ill-defined striae, 7 in 2 mm. of length; apparently smooth; stopping abruptly at the mesial depressions and at the shoulders of the grooves; curving across each half-face to make an arc convex towards the apex. Interspaces smooth, from one to two times as wide as the striae. Aperture and apex unknown.

Length, 36 mm; width of face, at least 7.5 mm.

*Type:* An external impression of two faces, and a length of 14 mm. of the original specimen; number 617 in the author's collection.

*Occurrence:* In the Upper Chazy near Cap St. Martin, north of Montreal. The precise locality is a quarry one-quarter mile east of the hamlet of Village Belanger.

*Remarks:* The preservation of the only specimen is not sufficiently good to permit a definite statement that the oblique shoulder striation,

seen in other species, is absent. The low, indistinct striae, and the course of these across the face, distinguish the species from the genotype, fragments of which might otherwise be confused with it.

***Conularina irrasa*, sp. nov.**

(Plate I, figures 1-3)

*Description:* Shell large, slightly curved in its present condition, tapering regularly. Test multilamellar, of 20 or more layers in places, thickest at the angles; the outer layer black, the inner layers usually brownish. Cross-section rhombic. Faces gently convex, equal, apical angle about  $13^{\circ}$ . Marginal grooves wide and shallow; the edges more or less rounded, angulate on the internal cast; the bottom almost flat and smooth. Mid-line with a narrow sub-median ridge flanked by shallow indefinite depressions. Surface with small, low, undefined folds; 3-4 in one mm.; horizontal or gently arched across each half-face, dying out at the mid-line; crossed near the angles by sharper grooves directed obliquely apicad. At one place, very fine, short, transverse grooves are seen at the mid-line of the face. The first inner shell layer bears fine, smooth, distant, thread-like striae, extremely irregular but roughly parallel to the surface folds. Apex and aperture unknown.

Length, 90 mm.; width of face, 30 mm.

*Type:* A partially exfoliated and somewhat crushed free specimen, number 335 in the author's collection.

*Occurrence:* With *C. undosa*, *q.v.* This locality, which has yielded most of the specimens of *C. triangulata*, also has *Blastoidocrinus*, *Camarotoechia*, *Hebertella*, *Eoharpes*, and other fossils including a host of unstudied bryzoans.

*Remarks:* One face of the shell is bent inwards at the larger end, but the crushed condition of the specimen makes its significance doubtful. For the same reason the straightness of the shell as a whole cannot be definitely stated. The size and ornamentation, especially that of the inner shell layer, are distinctive.

***Conularina raymondi*, sp. nov.**

(Plate II, figure 3)

*Description:* Shell small, straight, tapering regularly. Test very thin, of two layers, dark brown in colour. Faces evenly and strongly convex,

equal, apical angle  $10.5^{\circ}$ . Cross-section circular, indented at the margins of the faces. Marginal grooves 0.15 mm. wide (0.6 mm. on the cast), deep, the edges broadly rounded, the bottom flat due to extensive shell thickening. On the internal cast the groove shows as a sharply rounded V. Mid-line of the face marked by a low rounded ridge, on either side of which there is a slight depression. On each face the depression to the left of the mid-line is the stronger. Surface with many very fine, obscure transverse wrinkles, about 5 in one mm., slightly arched across the face. Apex and aperture unknown.

Length of holotype, 21 mm.; of the paratype, 13.5 mm. Width of face in the two specimens, 6.5 and 5 mm.

*Types*: Holotype in the author's collection, number 3; paratype in the Museum of Comparative Zoölogy at Harvard College, number 27,935. Both are free specimens in fairly good preservation.

*Occurrence*: The MCZ specimen was collected by Mr. Henry Seton at Valcour Island, in the Upper Chazy. The holotype was found at Cap St. Martin, Quebec, in a coquina similar to that at Village Belanger, although no other conularids were found in it. Besides many bryozoans this bed contains a large brachiopod fauna, with *Camarotoechia orientalis* most abundant.

*Remarks*: In the holotype the oblique striae on the shoulders are represented by extremely obscure wrinkles, only seen in oblique light. As usual, they cross the transverse ornamentation at a small angle. The sharper of the two depressions bordering the mesial elevation is sufficiently inflected to produce a distinct linear groove on the cast. The shape and the indistinct, arched ornamentation distinguish the species.

### ***Conularina narrawayi*, sp. nov.**

(Plate II, figure 4)

*Description*: Shell small, straight, tapering regularly. Test very thin, of two layers, black in colour. Faces slightly convex, equal, apical angle about  $14^{\circ}$ . Cross-section apparently square (not well seen). Marginal groove narrow (0.3 mm.), rather deep, the edges sharply rounded, the bottom marked by very irregular transverse wrinkles and internal thickening of the shell. Mid-line of the faces with a very narrow ridge, the flanking depressions inconspicuous. Surface with numerous (8 in one mm.), irregular, low, smooth folds or wrinkles, whose course across the face is slightly arched but very irregular. Aperture and apex unknown.

Length, 21 mm.; width of face, 9 mm.

*Type*: Royal Ontario Museum of Palaeontology, number 18,905. A somewhat distorted, free specimen, with the surface well-preserved in places. Collected by Mr. James A. Narraway of Ottawa, for whom it is named.

*Occurrence*: In the Ottawa limestone, at a horizon containing an abundant fauna of the age of the Leray in New York; at Tetreauville, Quebec, on the Ottawa River opposite the city of Ottawa. These are the beds in which Mr. Narraway found the type of *Metaconularia ? dubia* Sinclair (Trans. Royal Soc. Can., 1940, sec. iv, p. 107).

### **Climacoconus**, new genus

Small conularids bearing relatively large, smooth, transverse ridges which meet a prominent longitudinal keel at the mid-line of the faces.

*Genotype*: *Climacoconus quadratus* (Walcott).

The test as ordinarily seen is smooth, and usually black in colour. Exceptionally well-preserved specimens show that there was another external shell-layer which was extremely thin, lighter in colour, and capable of wrinkling. The cross-section of the shell as a whole may be rectangular or square; the specimens which are variously rhomboid are considered to be distorted. The keel is usually as high as the transverse ridges, and its prominence contrasts with the corresponding region in other conularids; it may be straight or zig-zag, and of course the latter condition is only possible where the ridges reach the mid-line alternately. There is no thickening of the shell or other internal structure at the mid-line, so far as is known. The preservation of the type of *C. clarki* (page 229) indicates a weakness of the test along the mid-line, and such a zig-zag keel might tend to strengthen it. It should be pointed out, however, that such a zig-zag course is known in one of the earliest species, *C. humilis*.

The marginal grooves are usually rather wide, and the shell thickened, so that on the internal cast the grooves are quite deep. The bottom of the groove is commonly marked by transverse wrinkles and by oblique extensions of the ridges. In some species the edges of the grooves are raised into definite ridges. The aperture is not known, nor is the nature of the apex clearly seen in any specimen. There is no evidence of an apical diaphragm, and some specimens suggest strongly that the shell continued to a point.

An examination of several specimens of *C. quadratus* from the upper

Trenton at Montreal indicates a consistency within the species in size and in the arrangement of the ridges and their number at any point. The apical angle, and the density of the ridges, and their arrangement, vary with the growth of the individual, but this variation is orderly and specimens of the same size exhibit the same characteristics. The criteria used in discriminating species (considering specimens of comparable growth) are: course of the keel; apical angles; and density, direction, and height of the ridges. The general size of the shell is also significant within limits.

Specimens of *Climacoconus* are usually very rare, but occur in America throughout the Middle and Upper Ordovician, from the Chazy to the Richmond. In Europe three species have been described, all from the Ordovician. The genus has not been reported elsewhere. It is evident from the appearance of "*Conularia quadrata*" in many faunal lists that the occurrences known and given below are not exhaustive.

The order of specific descriptions is: (a) the genotype, (b) other American species in order of age, and (c) European species.

### ***Climacoconus quadratus* (Walcott)**

(Plate III, figures 1-5)

1879. *Conularia quadrata* Walcott, 28th Ann. Rept., N. Y. State Museum, p. 93.

Walcott's original description is very brief, and the species has never been figured. For these reasons it has been subject to some confusion. The description here offered is drawn from the type, and from some additional specimens from Montreal.

Shell small, straight, tapering more rapidly towards the aperture. Test of two layers, both extremely thin; the outer creamy-white in colour, the inner black. Cross-section rectangular. Faces plane, unequal (about as 5:4), apical angle about  $12^{\circ}$  near the smaller end, increasing to  $18^{\circ}$  at the apertural end of large specimens. Marginal groove wide, open, deep; the edges sharp but not ridged; the bottom with minute transverse wrinkles. From between the ends of each two ridges an obscure elevation runs obliquely into the groove, in the direction of the aperture. Mid-line with a straight keel, not as high as the ridges. Surface with smooth transverse ridges, highest halfway between the margins and the keel, with sharply rounded crests, especially near the aperture. The ridges meet at the keel



at an angle of 135-140°. Apically the ridges tend to be straighter, more rounded on top, and proportionately wider. They alternate at the keel near the aperture, but apically they are opposite. There are about eight ridges in a length of 2 mm. near the apex, three or four at the middle of the shell, and two at the larger end. Interspaces smooth, about 1.5 times as wide as the ridges, somewhat less apically. Apex and aperture unknown, but some specimens indicate that the latter was probably pointed (see plate III, figure 5).

The larger end of the type specimen is not well preserved, and it is not possible to give accurate measurements of the whole shell. The length was at least 20 mm.; the greatest width of face actually preserved is 4 mm. Length of a typical Montreal specimen (plate III, figure 4) is 22 mm.; width of the faces, 6.5 and 5.5 mm.

*Type:* The holotype, number 27,933 in the Museum of Comparative Zoölogy at Harvard College, is imbedded in black limestone and exposes most of two adjacent faces. Figured specimens are in the collections of James A. Calder, Jr., and of the author.

*Occurrence:* Walcott's type was found in the "upper third of the Trenton limestone" at Prospect Bridge, Trenton Falls, New York. This would place it in the Lower Cobourg (Hallowell) formation. The Central Ontario divisions cannot be applied in the Montreal area, but the upper beds of the Trenton at Montreal, in which the species occurs, are believed to be of Cobourg age. Fragments are not uncommon in an old quarry just east of Sherbrooke Street in the town of Pointe aux Trembles, where they occur in an impure brown limestone with *Serpulites*, *Calymene*, *Sowerbyella* and *Rafinesquina*.

*Remarks:* It should be noted that the ridges do not enter the marginal grooves; the short oblique elevations which occur there originate opposite the interspaces.

*Climacoconus quadratus* has also been listed from various beds in the Cincinnati area, and from the Decorah in the upper Mississippi Valley. Since no specimens from these localities have been examined, no opinion is offered on their identity with the eastern species. A fragment, apparently of this species, was found in the lower Trenton near Bath, Ontario. Another fragment, from the Guttenberg member of the Decorah at Galena, Illinois, has been listed by Kay as *Conularia trentonensis* (Jour. Geol., xxvii, p. 659). Both these specimens are too poor to warrant specific identification, but they indicate the presence of a species of the *C. quadratus* type of structure.

**Climacoconus rallus**, sp. nov.

(Plate II, figures 11, 12)

*Description:* Shell small, straight, tapering regularly. Test very thin, only one layer seen, black in colour. Faces plane or slightly concave, equal, apical angle  $11.5^{\circ}$ . Cross-section unknown. Marginal grooves rather wide (0.5-0.6 mm.), deep; the edges sharp and raised; the bottom bearing obscure ridges running obliquely aperturad, as well as minute transverse wrinkles. Mid-line with a low straight keel, not as high as the ridges. These are extremely thin, very high, and sharp, the tops usually broken off; highest at the middle of the half-face, becoming lower at the keel and the margins; 9 in a length of 5 mm.; smooth, opposite at the keel, or nearly so; meeting at an angle of  $150^{\circ}$ ; stopping at the marginal groove, where they are alternately placed with reference to those on the adjacent face. Interspaces wide, 3 to 4 times as wide as the ridges, smooth. Apex and aperture unknown.

Length, 15 m.; width of face, 5 mm.

*Type:* A free flattened specimen belonging to James A. Calder, Jr., of Ottawa.

*Occurrence:* A quarry on the south side of provincial highway 18, two miles south of Terrebonne, Quebec, in the Upper Chazy.

*Remarks:* The transverse ridges are more distant than in any other species except *C. clarki*, and the largest specimens of *C. quadratus*. From both of these, *C. rallus* is distinguished by the sharpness of the ridges and the width of the interspaces. Whether the rate of tapering in more complete specimens would be uniform cannot be judged from those at hand.

**Climacoconus humilis**, sp. nov.

(Plate II, figures 6, 7)

*Description:* Shell small, straight, tapering regularly. Test extremely thin, one black layer seen. Faces plane, slightly unequal, apical angle about  $7^{\circ}$ . Cross-section rectangular. Marginal groove rather narrow, deep; the edge prominent and forming a slight ridge which is highest where the ridges cross it; the bottom marked by the interlocking ends of the transverse ridges. Mid-line marked by a broad mesial keel, not as high as the ridges, but highest where two of them meet at the same point; straight where the ridges are opposite, slightly zig-zag where they alternate. Surface with rather wide, prominent, smooth, nearly straight,

transverse ridges, 4-4.5 in a length of 2 mm.; alternating at the keel on one face, but opposite on the other; meeting at an angle of  $143^\circ$ ; bending abruptly towards the aperture on entering the marginal grooves. Interspaces about 1.5 times as wide as the ridges, and smooth. Aperture and apex unknown.

Length, 7 mm.; width of wider face, 3 mm.

*Type*: Number 4,753 in the Carnegie Museum. The specimen is imbedded in a grey sandstone, and exposes two faces.

*Occurrence*: Faribault, Minnesota, in the St. Peter sandstone.

*Remarks*: The zig-zag course of the keel is not seen in other early species, but it is prominent in the Richmond forms. The present species is quite similar to *C. quadratus*, but the size and small apical angle will distinguish it. Many specimens of the Trenton species are known in which the ridges alternate, but the keel is always straight.

#### ***Climacoconus clarki*, sp. nov.**

(Plate II, figures 8, 9)

*Description*: Shell of medium size, straight, tapering more rapidly towards the aperture. Test of two layers, as in the genotype. Faces plane, apparently equal, apical angle varying from  $10^\circ$  near the apex to  $16^\circ$  at the larger end. Cross-section square or rectangular (the equality of the faces is not certain). Marginal groove wide (one mm. at the larger end of the shell), deep, the edge angular with a slight ridge; the bottom marked by irregular transverse wrinkles and by the obscure extensions of the transverse ridges. Mid-line unknown. Surface with rather wide, high, transverse ridges, with smooth and broadly rounded crests, thinner and more sharply rounded on the internal cast; 9, 6.5 and 7 of these ridges occur in lengths of 5 mm., taken near the apex, at the middle of the shell and near the larger end, respectively. Ridges straight apically, but sharply geniculate near the aperture; bending towards the aperture in the marginal groove. Interspaces a little wider than the ridges, on the cast about 1.5-2 times as wide; smooth. Aperture and apex unknown.

Length, 30 mm.; width of half-face, 5 mm.

*Type*: In the Peter Redpath Museum, McGill University.

*Occurrence*: In the basal Trenton at Le Page Station, Quebec, about twenty miles north-west of Montreal. Collected by Prof. T. H. Clark, for whom it is named.

*Remarks*: The only specimen preserves halves of two adjacent faces, the

shell being broken evenly along the mid-line of each; there is no trace of the usual mesial keel. The specimen is otherwise undistorted, and the preservation of the delicate outer shell-layer indicates that it was not exposed to great attrition before burial. This species is larger than most of the genus; the geniculate transverse ridges and their density are distinctive.

**Climacoconus bromidus**, sp. nov.

(Plate II, figure 5)

*Description:* Shell small, straight, tapering more rapidly towards the apex. Test very thin, only one layer seen, of a light brown colour. Faces angularly concave (crushed?), equal, apical angle about  $13^{\circ}$  in the apical portion, becoming smaller in the younger part of the shell. Marginal groove rather shallow, 0.5 mm. wide at the larger end of the shell, the edge marked by a prominent ridge which is highest where met by the transverse ridges. Mid-line marked by a straight mesial keel, of the same height as the ridges. Surface with rather wide, smooth, sharply rounded transverse ridges, highest halfway between the margins and the keel; nearly straight, usually opposite at the keel, meeting at an angle of  $145^{\circ}$  near the aperture,  $135^{\circ}$  apically; 5 occur in one mm. of length near the apex, 3.5 nearer the aperture. Interspaces smooth, 1.5-2 times as wide as the ridges. Aperture and apex unknown, but the latter seems to have been pointed.

Length, 10.5 mm.; width of face, 2.7 mm.

*Type:* Number A 8,952, in the Museum of Paleontology, University of Oklahoma. The type is a flattened specimen, showing one face and most of an adjacent one.

*Occurrence:* Collected by Dr. Charles E. Decker in zone 6 of the Viola limestone, Sec. 2-2S-7E, Witch Hole, southwest of Bromide, Oklahoma. The fauna listed from this zone (Decker, Bull. Amer. Assoc. Petrol. Geol., xvii, p. 1419) seems to indicate a Middle or Upper Trenton age.

*Remarks:* The ridges are usually opposite at the keel, but in some places they alternate. This alternation may take place where there is continuity on the adjacent face. The ridges continue into the marginal groove, at the bottom of which they alternate and interlock; they are bent sharply towards the aperture on entering the groove. This species is distinguished by its small size, crowded ridges, and the ridged nature of the edges of the grooves. This is the species which has been listed from Witch Hole as "*Conularia trentonensis*," but there are other species of conularids in the Viola.

**Climacoconus pumilus**, sp. nov.

(Plate II, figure 10)

1929. *Conularia pumila* Ladd, Ann. Rept. Iowa Geol. Survey, xxxiv, p. 384 (*nom. nud.*)

*Description:* Shell minute, straight, tapering regularly. Test unknown. Faces plane, equal, apical angle  $9.5^\circ$ . Cross-section square. Marginal groove narrow, rather deep, the edges sharply rounded but not ridged, the bottom angular. Mid-line of the faces marked by a regular zig-zag ridge, of which the elements meet at an acute angle. Surface with smooth, wide, low, straight, rounded transverse ridges, 9 in a length of 1.6 mm.; alternating at the keel, stopping at the shoulders of the marginal grooves. Interspaces smooth, 1-1.5 times as wide as the ridges. Aperture and apex unknown.

Length, 1.7 mm.; width of face, 0.8 mm.

*Type:* A free cast, preserving two faces well; collected by Dr. Harry S. Ladd, and now in the U. S. National Museum.

*Occurrence:* In the "Depauperate" zone of the Maquoketa, Clermont Township, Fayette County, Iowa. The precise locality is described by Ladd in the paper cited, page 376.

*Remarks:* As is the case with the other "depauperate" Maquoketa species, this is not a small specimen of some other species, but is a unique form. It is not liable to confusion with other species.

**Climacoconus batteryensis** (Twenhofel)

(Plate III, figure 7)

1929. *Conularia batteryensis* Twenhofel, Mem. Geol. Survey Canada, 154, p. 255, pl. xxvi, 9.

*Description:* Twenhofel's description may be arranged, with some minor additions, to read: Shell small, straight, tapering regularly. Test thin. Faces flat or very slightly convex, equal, apical angle about  $18^\circ$ . Cross-section rhombic. Mid-line marked by a zig-zag ridge, made up of components which are about one mm. long, and which meet at a right angle. Marginal grooves concave, with sharp edges. Transverse ridges distant, 8 per 5 mm. at the smaller end of the shell, 11 at the larger; straight, almost smooth, slightly rounded; meeting the keel at the projecting angles to form with them an angle of about  $140^\circ$ . Interspaces wide, nearly flat, smooth.

Length, 23 mm.; greatest width of face, 6 mm.

*Type:* A well-preserved free specimen in the Peabody Museum of Natural History, Yale University, numbered 10,367.

*Occurrence:* In zone 4 of the Vauréal formation, at Battery Point, Anticosti Island, Quebec. This zone carries an abundant and varied fauna which has been described in detail by Twenhofel in the memoir cited. The Vauréal is correlated with the upper Richmond of the Mississippi Valley.

*Remarks:* The strongly zig-zag keel is sufficient to distinguish the species from all the earlier forms. Fragments of a similar species have been found in beds of Richmond age at Deer Island, Lake Winnipeg, but they are too poor to permit detailed comparison. The form listed by Ladd (1929, p. 394) from the Fort Atkinson member of the Maquoketa as *Conularia sp.* is another similar species, also too fragmentary for description. A third form related to *C. batteryensis* is indicated by a specimen found in the drift near Winnipeg, Manitoba, and likely derived from the Cat Head formation north of that place.

### ***Climacoconus bottnicus* (Holm)**

(Plate III, figure 9)

1893. *Conularia bottnica* Holm, Sver. Geol. Unders. C112, p. 136, text figure.

1908. *Conularia bottnica* Wiman, Bull. Geol. Inst. Upsala, viii, p. 142.

Holm's description may be freely translated:

Medium sized species. Shell tapering regularly, apical angle about 25°. Cross-section quadratic. Faces plane, with a mesial narrow, sharp, ridge, of about the same height and form as the transverse ridges, but a little thinner. Marginal groove comparatively wide, shallow and flat, the edges sharply angulated.

Sculpture fairly coarse, of obtusely angulated ridges only. These are very high and sharp, numbering 7-8 in 5 mm. The crests are not seen, being broken in the matrix. Interspaces about three times as wide as the ridges, rounded and smooth on the bottom, without any longitudinal furrows except near the point of the shell, where very feeble and thin ones occur. The marginal groove also has obtusely angulated transverse ridges with the angle directed forward, but here they are considerably weaker, disappearing towards the mid-line of the groove, and most often arranged more or less zig-zag.

Almost complete fragments have a breadth at the aperture of 12.5 mm., marginal groove at the same place 1.5 mm., and length at least 30 mm.

The species was found in the Östersjö limestone (Upper Ordovician) at Upland, Sweden. Wiman reports it from the same beds.

This species is much wider than any American form, and its regularly

opposite transverse ridges are not seen in any of our species. In this feature, but in this one only, it agrees with *C. scoticus* (Lamont).

***Climacoconus scoticus* (Lamont)**

(Plate III, figure 8)

1934. *Conularia scotica* Lamont, Geol. Mag., lxxi, p. 224, pl. xi, figures 8-9, text figure 1.

Lamont's description:

Shell small, thin, tapering more rapidly towards the apex. Marginal grooves well developed, with raised rims between which there is a fine longitudinal furrow. Faces, flat to slightly concave, ornamented with strong transverse ridges, evenly distributed, narrower and less rounded than the interspaces, forming rounded angles of about  $135^\circ$  and also bending forward at the lateral ends.

Apertural lobes and apex unknown.

*Type:* In the Hunterian Museum, University of Glasgow.

*Horizon and locality:* Mudstones (Caradocian), Balclutchie, Girvan, Scotland.

*Remarks:* The transverse ribs [number] 34 in 9 mm. Ridges fully observed are smooth. The apical angle appears to be as much as  $25^\circ$ , but towards the aperture the sides are increasingly parallel and only make an angle of about  $17^\circ$ . Adjacent faces probably slightly unequal in width.

On the left posterior edge of the specimen, the narrow, longitudinal furrow of the marginal groove is seen lying between rims much broader than itself. Part of one rim is seen carrying an additional fine longitudinal striation. The rim-material conceals the lateral extension of the ridges. On the right side of the specimen, the superficial rim-material has been detached. The ridges seem to swell slightly where they encroach upon the marginal groove, within which they are bent somewhat forward.

In general aspect this species is similar to some of the American forms, but the regularly opposite ridges distinguish it. The course of the ridges is unique, and affords a ready distinction from *C. bottnicus*. None of the American specimens examined throw any light on the interesting structure of the edges of the marginal grooves described by Lamont.

***Climacoconus ? lanceolatus* (Krause)**

(Plate III, figure 6)

1877. *Conularia lanceolata* Krause, Zeits. d. d. geol. Gesell., xxix, p. 24, pl. i, 10.

Krause's brief description may be freely translated:

A small form with rhombic cross-section, 4 mm. in length and 1.5 mm. wide at the base (*i.e.* the maximum diagonal, not the width of the face), apex only slightly

rounded. The four angles with a deep furrow; the faces with numerous angulated transverse ridges and a median line uniting the points of geniculation. In the present specimen 26 such ridges occur, so that there are 6 or 7 in one line.

In view of this slight description the species is placed in this genus with some hesitancy, but it would seem likely that this is its proper position. Krause's specimen came from the drift and was supposed (with some doubt) to be derived from the Beyrichia limestone (Lower Ordovician).

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## EXPLANATION OF PLATE I

FIGS. 1-3. *Conularina irrasa*, sp. nov.

1, 2. The specimen,  $\times .75$ . The author's collection, no. 335. Upper Chazy, Village Belanger, Quebec.

3. The surface of the same,  $\times 2$ , showing the distant thread-like striae on the inner shell-layer.

FIGS. 4-10. *Conularina triangulata* (Raymond).

4. Specimen from Mr. Calder's collection. Upper Chazy, near Terrebonne, Quebec. Part of the surface,  $\times 7.5$ , to show the oblique striations on the shoulder.

5. The same specimen. Surface,  $\times 7.5$ .

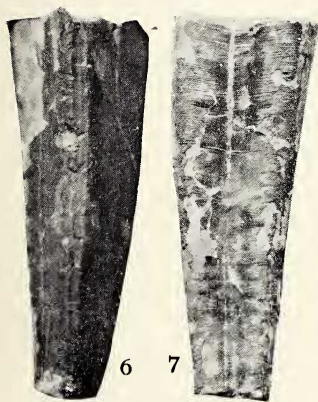
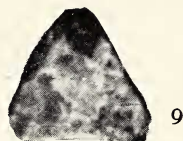
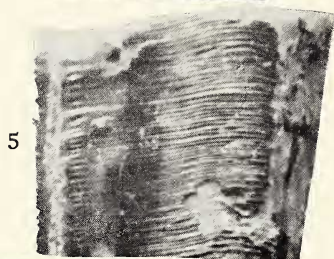
6. The same specimen,  $\times 2$ , from one of the angles.

7. The same specimen,  $\times 2$ , from one face.

8. The holotype,  $\times 2$ . no. 2,099, the Carnegie Museum. Upper Chazy, Valcour Island, N. Y.

9. View of the larger end of the specimen shown in figures 4 to 7,  $\times 2$ .

10. An internal cast, no. 76 in the author's collection,  $\times 2$ . Showing the mesial ridge and the faint impression of the surface striae.







## EXPLANATION OF PLATE II

- FIGS. 1-2. *Conularina undosa*, sp. nov.  
 1. An impression of two faces,  $\times 1.25$ . The author's collection, no. 617. Upper Chazy, Village Belanger, Quebec.  
 2. Counterpart of the same specimen,  $\times 2$ , to show the structure of the mid-line and the nature of the transverse striae.
- FIG. 3. *Conularina raymondi*, sp. nov.  
 The holotype,  $\times 1.5$ . The author's collection, no. 3. Upper Chazy, Cap St. Martin, Quebec.
- FIG. 4. *Conularina narrawayi*, sp. nov.  
 The holotype,  $\times 2$ . Royal Ontario Museum of Palaeontology no. 18,905. Ottawa limestone (Leray horizon), Tetreauville, Quebec.
- FIG. 5. *Climacoconus bromidus*, sp. nov.  
 The holotype,  $\times 2.5$ . Museum of Paleontology, University of Oklahoma, no. A8,952. Viola limestone, Witch Hole, Oklahoma.
- FIGS. 6-7. *Climacoconus humilis*, sp. nov.  
 6. One side of the type,  $\times 2$ . Carnegie Museum, no. 4,753. St. Peter sandstone, Faribault, Minn. To show the opposite ridges and straight keel.  
 7. The same specimen, an adjacent face,  $\times 2$ . To show the alternation of the ridges at the zig-zag keel.
- FIGS. 8-9. *Climacoconus clarki*, sp. nov.  
 Two views of the type,  $\times 2$ . Redpath Museum, McGill University. Basal Trenton, Le Page Station, Quebec.
- FIG. 10. *Climacoconus pumilus*, sp. nov.  
 The type,  $\times 9.5$ . The U. S. National Museum. Depauperate zone of the Maquoketa, Fayette County, Iowa.
- FIGS. 11-12. *Climacoconus rallus*, sp. nov.  
 Two views of the type,  $\times 2$ . From Mr. Calder's collection. Upper Chazy, near Terrebonne, Quebec. To show the thin ridges, and the projections into the marginal grooves.